International Journal of Surgery 7 (2009) 526–528

Contents lists available at ScienceDirect

International Journal of Surgery

journal homepage: www.theijs.com

Ultrasound-guided catheterization of the internal jugular vein in oncologic patients; Comparison with the classical anatomic landmark technique: A prospective study

Konstantinos Serafimidis, George H. Sakorafas*, George Konstantoudakis, Konstantina Petropoulou, George P. Giannopoulos, Nikolaos Danias, George Peros, Michael Safioleas

From the 4th Department of Surgery, Athens University, Medical School, ATTIKON University Hospital, Arkadias 19–21, GR-115 26 Athens, Greece

ARTICLE INFO

Article history:
Received 4 July 2009
Accepted 17 August 2009
Available online 12 September 2009

Keywords:
Central vein
Internal jugular vein
Catheterization
Image-guided
ICU
Monitoring
Chemotherapy

ABSTRACT

Aim: To compare the traditional anatomic landmark technique with the ultrasound-guided method for central venous catheterization.

Material and methods: During three years, 551 patients underwent internal jugular vein catheterization; in 347 patients, the ultrasound-guided technique was used, while in the other 204 patients the catheter was introduced by using the classical anatomic landmark method. Operating time, complications (pneumothorax, puncture of carotid artery with or without hematoma formation), and number of attempts to achieve central venous catheterization were recorded.

Results: The ultrasound-guided technique was associated with significantly shorter operating time (9.83 ± 3.1 vs. 20 ± 4.4 min, $p < 0.001$) and less morbidity (pneumothorax, 0 vs. 2 patients [$p < 0.05$], carotid artery puncture with or without hematoma formation, 1 vs. 16 patients [$p < 0.05$]). Moreover, the ultrasound-guided technique was highly successful in achieving central venous catheterization (failure, 0 vs. 18 patients [$p < 0.05$]), with significantly fewer attempts (1–3 attempts in 204 vs. 283 [$p < 0.01$]), compared to the classical anatomic landmark technique.

Conclusion: The ultrasound-guided method is faster, more efficient, and less morbid procedure compared with the classical anatomic landmark technique. Therefore, it should be preferred over the classical landmark method, especially in high-risk patients for the development of complications.

1. Introduction

Central venous catheterization is a commonly performed procedure in modern clinical practice. Its indications have recently significantly expanded and currently include a wide range of diseases or pathological conditions, not only in critically ill patients. However, central vein placement is associated with a potential morbidity (from 5% to 10%), including arterial puncture, large local hematoma, injury of the vein wall and soft tissue, injury to the pleura, plexus branchialis and peripheral nerves.[1]

Traditionally, central venous catheterization is performed by using the anatomic landmark technique.[2,3] In an attempt to increase success rates and minimize morbidity, the ultrasound-guided technique has been proposed.[4] The aim of this study is to present our experience with this technique.

2. Material and methods

During the last 3 years (July 2004–June 2007), central venous catheterization has been performed, for a variety of indications, in 551 patients. In 347 patients, the ultrasound-guided technique had been used, while in the others 204 patients the catheter was introduced by using the classical blind technique, using anatomic landmark structures.

2.1. Anatomic landmark technique

The needle is inserted through the skin at the posterior lateral margin of the sternocleidomastoid muscle, approximately 4 cm above the sternoclavicular junction, near the point at which the external jugular vein crosses the posterior margin of the sternocleidomastoid muscle. The needle is advanced a maximum of

* Corresponding author. Tel.:/fax: + 30 210 74 87 192.
E-mail address: georgesakorafas@yahoo.com (G.H. Sakorafas).

1743-9191/$ – see front matter © 2009 Surgical Associates Ltd. Published by Elsevier Ltd. All rights reserved.
doi:10.1016/j.ijsu.2009.08.011

3–4 cm in an inferomedial direction, toward the contralateral nipple. The needle syringe is held at an angle approximately 10–15°. After puncturing the internal jugular vein, the catheter is introduced using the Seldinger technique.

2.2. Ultrasound guided technique

A 7.5 MHz linear-array ultrasound probe connected to a real-time ultrasound is used, covered with gel and wrapped in a sterile plastic sheath. By using real time ultrasonography, the operator can measure the depth and caliber of the internal jugular vein, evaluate its patency and recognize any thrombi within it. The needle is advanced about 2 cm above and parallel to the clavicle, under real-time ultrasonographic guidance (which allows the identification of the needle, internal jugular vein and carotid artery) and inserted into the internal jugular vein. Central venous catheter placement is then performed by using the Seldinger technique (Fig. 1, a and b).

Operating time was recorded. Chest X-ray was performed in all patients to exclude pneunothorax. Complications such as puncture of the carotid artery with or without hematoma formation were recorded, as well as failure to achieve central venous access. The number of attempts to achieve central venous access was also recorded.

3. Results

Statistical analysis was performed by using the *t*-test and the x2-test.

The results of this study are summarized in Table 1. Significant differences in favor of the ultrasound-guided technique were observed in group B, regarding operating time and complications rate (pneumothorax and carotid artery puncture/injury). Moreover, the ultrasound-guided technique was successful in all patients, in contrast to the anatomic landmark technique, which failed to achieve central venous access in 18 patients (5%). Finally, more than 3 attempts to achieve venous access were required in 64 patients of group A (18%), while in group B central venous catheterization was successful in all patients with 1–3 attempts.

Table 1
Comparison between the anatomic landmark and the US-guided technique.

	Group A[a] (n = 347)	Group B[b] (n = 204)	p value
Operating time (min)	20.02 ± 4.4	9.83 ± 3.1	< 0.001
Pneumothorax	2	0	< 0.05
Carotid injury-hematoma	16	1	< 0.05
Failure to achieve central venous access	18	0	< 0.05
Number of attempts			
1–3	283	204	< 0.01
> 3	64	0	

[a] Group A. The anatomic landmark technique.
[b] Group B. US-guided technique.

4. Discussion

During the last two decades, central venous catheterization has been increasingly used in clinical practice. However, despite the increased experience from the part of many clinicians, who perform central venous catheterization, the classical anatomic landmark method is associated with a small but potentially significant morbidity.[1] The ultrasound-guided technique is another alternative method for central venous catheter placement.[4] In this method, the needle is advanced under ultrasonographic guidance (real-time), allowing its safe introduction into the internal jugular vein, while the carotid artery is visible during the procedure.

The ultrasound guided technique requires the appropriate devices and an adequately trained operator. However, it has many important advantages. First of all, it allows direct visualization of the great vessels of the neck. This has a significant clinical importance, given that the internal jugular vein shows a great variability in its anatomic position relative to carotid artery, as shown in Fig. 2.[5] IJV could not be accurately predicted by external landmarks in 5.5% of patients.[6] Moreover, the diameter of this vessel shows great variability and the operator may choose to insert the catheter from the other side if the jugular vein has a small diameter (< 7 mm) or if it is stenosed (for example, after previous catheter insertion and administration of chemotherapy via this route).[7,8] Interestingly, in the study by Forauer et al., 35% of patients had a significant US finding before the procedure and necessitated

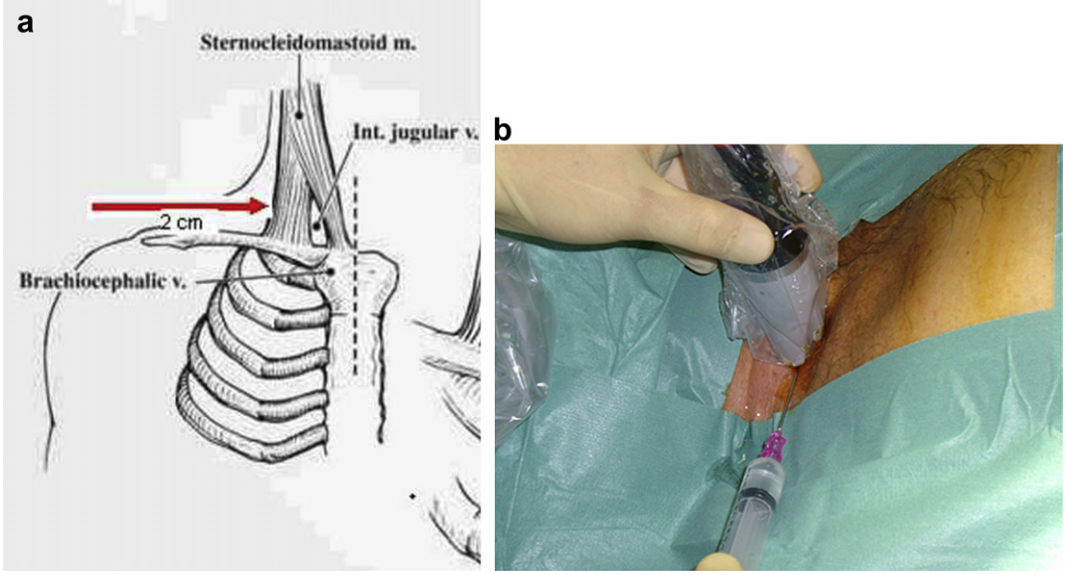

Fig. 1. Technique of ultrasound-guided catheterization of the internal jugular vein. The needle is inserted parallel to and 2 cm above the clavicle (a), under real-time ultrasound guidance (b).

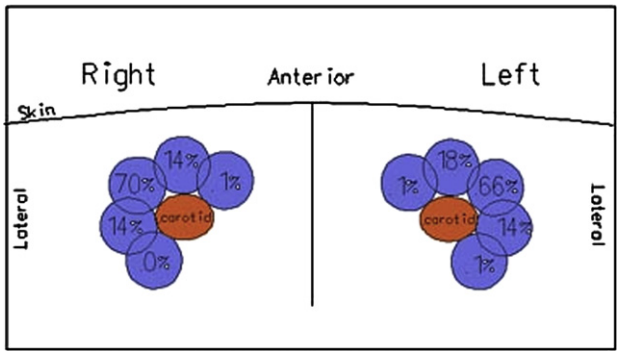

Fig. 2. Possible relations of the internal jugular vein with the carotid artery (left and right).

a change in the access approach in 75%.[7] Thus, under ultrasound guidance, the success rate of central vein catheterization is significantly increased.[9] This is especially important, since it is very well known that repeated unsuccessful attempts are associated with increased complication rates.[10] The increased success rate has as a result the significant decrease of the operating time. At the same time, the puncture/injury of the carotid artery and the double-wall puncture can be avoided.[11] Finally, by keeping the needle parallel to the clavicle and about 2 cm above it, the danger of pneumothorax is practically totally eliminated, as we have shown in our study. The safety of the ultrasound guided technique may be especially important in selected group of patients, such as un-cooperative or very obese patients (where the location of the anatomic landmarks may be difficult), in patients with increased risk for pneumothorax (patients under mechanical ventilation or with chronic obstructive pulmonary disease), but also in patients with hematological or neoplastic disease (where catheter placement involves an additional risk due to disease- or treatment- related thrombocytopenia or other disorders of hemostasis).[8,9,12] Obviously, the increased success rate and safety result in significant decrease of patient's discomfort, and thus this method is much more appealing for both the patient as well as the clinician.

In conclusion, the ultrasound-guided technique is a safe, highly effective and cost-efficient method in achieving central venous access and is associated with high patient satisfaction. Therefore, we recommend its use instead of the classical anatomic landmark method for central venous cathererization in all patients, in particular when there is increased risk for complications.

Conflict of interest
None declared.

Funding
None declared.

Ethical approval
None declared.

References

1. Sznajder JI, Zveibil FR, Bitterman H, Weiner P, Bursztein S. Central vein catheterization. Failure and complication rates by three percutaneous approaches. *Arch Intern Med* 1986;**146**:258–61.
2. Rao TLK, Wong AY, Salem MR. A new approach to percutaneous catheterization of the internal jugular vein. *Anesthesiology* 1977;**46**:362–4.
3. Daily PO, Griep RB, Shumway NE. Percutaneous internal jugular vein cannulation. *Arch Surg* 1970;**101**:534–6.
4. Machi J, Takeda K, Kakegawa T. Safe jugular and subclavian venipuncture under ultrasonographic guidance. *Am J Surg* 1987;**153**:321–3.
5. Gordon AC, Saliken JC, Johns D, Owen R, Gray RR. US-guided puncture of the internal jugular vein: complications and anatomic considerations. *J Vasc Interv Radiol* 1998;**9**:333–8.
6. Denys BG, Uretsky BF. Anatomic variations of internal jugular vein location: impact on central venous access. *Crit Care Med* 1991;**19**:1516–9.
7. Forauer AR, Glockner FG. Importance of US findings in access planning during jugular vein hemodialysis catheter placement. *J Vasc Interv Radiol* 2000;**11**:233–8.
8. Oquzkurt L, Tercan F, Kara G, Torun D, Kizilkilic O, Yildirim T. US-guided placement of temporary internal jugular vein catheters: immediate technical success and complications in normal and high-risk patients. *Eur J radiol* 2005;**55**:125–9.
9. Mey U, Glasmacher A, Hahn C, Gorschluter M, Ziske C, Merqelsberg M, et al. Evaluation of an ultrasound-guided technique for central venous access via the internal jugular vein in 493 patients. *Support Care Cancer* 2003;**11**:148–55.
10. Mallory DL, McGee WT, Evans RG, Brenner M. A multicenter study evaluates safety and technical aspects of central vascular cannulation. *Chest* 1989;**19**:295S–301S.
11. Augustides JG, Diaz D, Weiner J, Clarke C, Jobes DR. Current practice of internal jugular venous cannulation in a university anesthesia department. *J Cardiothorac Vasc Anesth* 2002;**16**:567–71.
12. Mumtaz H, Williams V, Hauer-Jensen M, Rowe M, Henry-Tillman RS, Heaton K, et al. Central venous catheter placement in patients with disorders of hemostasis. *Am J Surg* 2001;**180**:503–6.